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## Differently Fundamental – Micro-structural Approach to Determining PLN/EUR Central Rate for ERM II

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### Introduction

An attempt to join the European Monetary System is definitely one of the greatest challenges that authorities in charge of economic policy in Poland will face this decade. It has even become more challenging recently when (in some European countries being already members of Eurosystem) nostalgia for national currencies has suddenly risen and, on the other hand, the new government in Poland is not conspicuously enthusiastic about the idea either. Admittedly, the expectations were much ahead of what the eurozone has delivered. There are many reasons for this.

First, it is difficult to succeed with one monetary policy and several fiscal policies. The single monetary policy must be applied to very different economies and deal with divergent economic cycles, divergent inflation and economic growth rates. Before the year 2000, such countries as Italy periodically allowed the lira to depreciate against the mark in order to regain competitiveness with other European economies. Now, devaluation is not an option any more. This is one of the reasons why, although never publicly endorse the idea, some Italian politicians (R. Maroni) repeatedly express concern about the long-term sustainability of the euro. Blaming euro for national problems happens occasionally in other European countries (Greece and Portugal). A poll taken in May 2005 (for Stern magazine)<sup>1</sup> suggests that 56 % of Germans opt for bringing back the Deutsche mark.

Second, introducing euro was to force European countries to liberalize their economies. In some countries (France and Germany), however, liberalization was opposed by voters and trade unions and is still extremely unpopular. This counteracts economic reforms that were supposed to be implemented in order to improve economic flexibility. The consequences show in the statistics: unemployment in the eurozone for years has stayed high and growth is lagging behind this of the main benchmark country – USA.

Another obstacle is that monetary union requires a political union in the long

run. But rejection of the constitution in France and Holland raises doubts about Europe's commitment to further political union.

To sum up, as Scott McNeally states: "the eurozone is trapped in an environment in which monetary policy has become disfunc, fiscal policy unsustainable and national economies remain too inflexible to adjust to globalization or the recent EU's enlargement"<sup>2</sup>.

All this, however, does not mean that the common currency is reversible. First, the Maastricht treaty that established the currency has no withdrawal provision. Besides, the country that wished to withdraw would be exposed to the risk of higher interest rates and reluctance of foreigners to invest, in general greater political risk.. As O. Issing<sup>3</sup> (chief economist of ECB) said "a debt itself that is denominated in euro is a disincentive that is strong enough for such a country to leave". He also warned that members wanting to leave the eurozone would commit "economic suicide".

On the other hand, euro has been a great success. Traveling within the 12 countries has become much easier, companies are not exposed to exchange rate risk any more and avoiding the transaction costs directly translates into faster growth. S. Edwards and I. Magendzo (Edwards 2003) analyzed whether "common currency" countries have outperformed countries that have a currency of their own and showed that the former ones have lower inflation and higher growth (higher volatility though) than countries with domestic currencies.

As the paragraph above highlights the financial unification of Europe is still a work in progress. In Poland, joining the eurozone is still one of the government's priorities. But, there are also a number of steep hurdles. First, reaching a high degree of convergence with the euro zone countries is a precondition for the country to be admitted to the ERM II. There are four convergence conditions to be met. They are related to: public debt, budget deficit, inflation level and the level of long-term interest rates. Paradoxically, the need to meet the convergence criteria may appear to be one of the major benefits from joining the eurozone, much more important than billions of euros that a country like Poland can absorb from European Union's structural funds. It may simply impose the necessary fiscal and monetary discipline and prevent politicians from tinkering with the economy.

What immediately precedes entering ERM II however is the need to determine central PLN/EUR exchange rate. In A. Wojtyna's opinion, "the choice of the central rate will be extremely difficult. There is neither a theoretical model nor empirical research that may suggest how to find the equilibrium rate" (Wojtyna 2003).

This paper attempts to provide a solution to the problem. It presents a theoretical framework as well as a mathematical model that can be implemented and generate adequate equilibrium PLN/EUR exchange rate. According to the ECB (ECB 2002) "it is important to set a central parity that corresponds to the best possible assessment of current economic fundamentals, knowing that this will not prejudice the ultimate conversion rate". On the other hand, rejecting market spot rates and market-based forecasts just on the ground that they do not converge with some fundamentals

seems too arbitrary a solution. Thus, anticipating future spot rates (attempted in this paper), although tantamount to solving only a part of the problem, appears to be a good starting point for setting the central exchange rate. In fact, we will never know where the equilibrium rate is until it is market tested. This is where the ERM II comes in handy. It is designed as an ultimate test of the consistency of a central parity with a long-term fundamental equilibrium. The main intention of creating the ERM II was to “offer a meaningful framework for combining nominal and real convergence and should therefore not be seen as a mere anti-chamber before the adoption of the euro” (ECB 2002). On the contrary, the process of finding the equilibrium exchange rate will greatly be facilitated, as A. Koronowski acknowledges (Koronowski 2003). Apart from providing credibility (ECB supervision), supporting instruments that make the test feasible (Very Short Term Facilities), enforcing macroeconomic policy discipline (need to fulfill the fiscal and monetary convergence criteria), the fact of setting a central rate *per se* is significant as it triggers the very well known in finance mean reverting behavior conducive to the exchange rate stabilization (Williamson 2000). The fact of setting the central rate is reflected in the traders’ expectations and shows through the futures rates that are less volatile than the spot rates. Besides, once the central rate weathers the “purgatory” as the ERM II is often called, the conversion rate may not have to be exactly equal to the central rate.

## 1. Fundamental Forward Rate Model

Futures market analysis is the starting point for building the model. There are two major rates that are analyzed. Forward rate is basically determined by the difference in interest rates home and abroad. Any departure from the interest rate parity is noticed by arbitrageurs who drive it close to theoretical forward rate. The future spot rate, however, is hardly predictable and badly correlated with the forward rate. Hence, one of the major assumptions of the paper is that the market forward rate is significantly warped by arbitrageurs’ activity. If their influence was filtered out, the forward rate would reflect the fundamental signals that really affect the market expectations with regard to future exchange rates.

Therefore, there are two informed, influential groups of traders on the market: arbitrageurs (group A) whose behavior is somewhat automatic and driven by interest rate parity and fundamental traders (group F) – here belong commercial traders who use the futures market for hedging but also all the traders who refer to wider than just interest rate differential range of information. The abstract future rate that they have in mind is the Fundamental Forward Rate. The market forward rate is actually stretched between two extremes: one being the theoretical rate (reference point for arbitrageurs), the other – fundamental forward rate known to fundamental traders. Where exactly the fundamental rate is and how strong the both forces are is a subject of the research. The main problem is how to measure the degree and direction of the activity of both kinds of traders. This was established by analyzing historical data from the Warsaw Stock Exchange and then the Chicago Mercantile Exchange.

## 2. The market microstructure

In some markets unsolicited reports that incorporate information about their microstructure (Lyons 2002, O'Hara 1995) have appeared for some time providing researcher as well as traders themselves with valuable data. Commitment of Traders Reports (Rockefeller 2002) published weekly by Commodity Futures Trading Commission is one of the examples. The traders are classified either as "commercials" or "non-commercials"<sup>4</sup>. All of a trader's reported futures positions in a commodity are classified as commercial if the trader uses futures contracts in that particular commodity for hedging. A trading entity generally is classified as a „commercial" by filing a statement with the Commission (on CFTC Form 40) that it is commercially engaged in business activities hedged by the use of the futures or option markets. Traders of both categories stipulate from 70 to 90% of the market. The others are called "nonreportable positions" and these are the traders who only occasionally are involved in trading.

Table 1: An example of Commitment of Traders' Report (June 13, 2000).

Wheat - Chicago Board of Trade					Reportable Positions as of 06/13/00			
NON-COMMERCIALS			COMMERCIAL		TOTAL		NONREPORTABLE POSITIONS	
LONG	SHORT	SPREADING	LONG	SHORT	LONG	SHORT	LONG	SHORT
(CONTRACTS OF 5,000 BUSHELS)					OPEN INTEREST: 132,258			
COMMITMENTS								
23,191	29,74	17,964	51,732	61,646	92,887	109,35	39,371	22,908
CHANGES FROM 06/06/00 (CHANGE IN OPEN INTEREST: 1,652)								
-1,627	-664	-1,407	3,071	5,534	37	3,463	1,615	-1,811
PERCENT OF OPEN INTEREST FOR EACH CATEGORY OF TRADERS								
17.5	22.5	13.6	39.1	46.6	70.2	82.7	29.8	17.3
NUMBER OF TRADERS IN EACH CATEGORY (TOTAL TRADERS: 277)								
94	79	68	59	55	200	175		

Source: [www.cftc.gov/cftc/cftccotreports.htm](http://www.cftc.gov/cftc/cftccotreports.htm)

Unfortunately so far such reports have been published by commodity exchanges only. They are weekly reports that provide aggregate information. Still, it is an important tool that may be useful for predicting price changes.

### 3. Two forces and two types of traders in the futures market

The main assumption of the paper is that the market forward rate is located between two values: the theoretical value (represented by the A traders) and the fundamental value (represented by the F traders). The main problem is how to measure the degree and direction of the activity of both kinds of traders. We hypothesized that how the forward rate diverges from its theoretical value may be an indication of the degree and direction (see the arrows below) of the activity of both kinds of traders.

There are two possible situations.

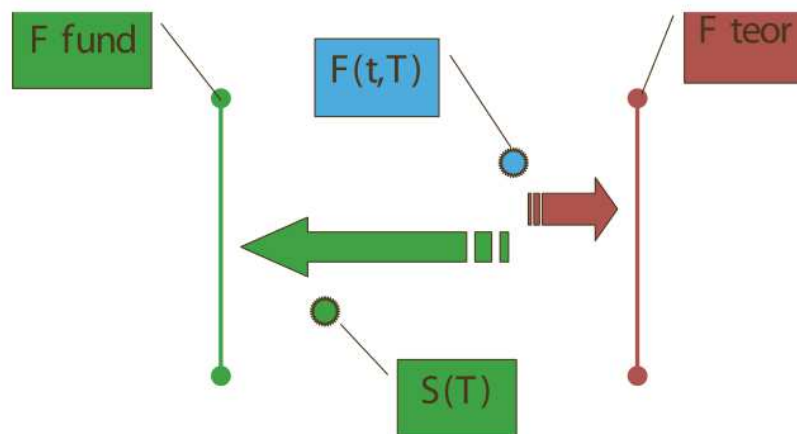
$$(1) \quad F^{fund}(t, T) < F(t, T) < F^{teor}(t, T)$$



$$(2) \quad F^{fund}(t, T) > F(t, T) > F^{teor}(t, T)$$

The situation expressed by inequalities (1) means F traders expect that  $S_T < F^{teor}(t, T)$ . Simultaneously, the opposite force (2) suggests that  $S_T > F^{teor}(t, T)$ .

The value of the forward rate that is lower than the theoretical one implies that the future spot rate will also be lower, and vice versa. This is illustrated below.



The formula (3) below is a natural consequence of this reasoning.

$$(3) \quad F^{fund}(t, T) = F^{teor}(t, T) + a \times (F(t, T) - F^{teor}(t, T)) \times p$$

where:

$a, p$  – (temporarily unknown) correctional values.

We hypothesized that the model (3) enabled us to determine the direction in which the future spot rates will change. The relationships (4) and (5) must be verified in order to prove that.

$$(4) \quad F(t, T) < F^{teor}(t, T) \Rightarrow S_T < F^{teor}(t, T)$$

$$(5) \quad F(t, T) > F^{teor}(t, T) \Rightarrow S_T > F^{teor}(t, T).$$

The sample that was chosen included all PLN/EUR futures rates with one-month maturities traded on the Warsaw Stock Exchange between the years 1999 – 2003. The theoretical rates were calculated with WIBOR and EURO LIBOR 1M values. It appears that (4) and (5) were proven accurate in 70% of the cases.

In addition to this, correlation between  $F(t, T) - F^{teor}(t, T)$  and  $S_T - F^{teor}(t, T)$  was found to be significant. This may indicate that not only the direction but also the extent to which the two forces affect the futures rate could be extracted from the data.

The Polish futures market is not extremely liquid. Hence, there was a need to test the hypothesis elsewhere. Another round of research was conducted with Euro FX futures contracts traded on the Chicago Mercantile Exchange. This time positive results, meaning that (4) and (5) do work, stipulate 65% of the cases.

However, equation (3) previously derived must be modified. The  $F(t, T) - F^{teor}(t, T)$  values do not change proportionally to  $S_T - F^{teor}(t, T)$  values. Besides, the linear model could generate negative values of the forward rates. This observation paves the way for a new version of the model (3) as shown in (6).

$$(6) \quad F^{fund}(t, T) = F^{teor}(t, T) + a \times \text{sgn}(F(t, T) - F^{teor}(t, T)) \times |F(t, T) - F^{teor}(t, T)|^q$$

#### 4. Calibration of the model

Parameters  $a, q$  were calibrated by maximizing the correlation between  $F(t, T) - F^{teor}(t, T)$  and  $F(t, T) - S_T$ . Simultaneously, the  $F^{fund}(t, T) - S_T$  difference is minimized.

Gradually, the assumption concerning only two groups of traders was relaxed. Uninformed traders (the model by Glosten and Milgrom that shows the relationship between bid-ask spread and the activity of the uninformed traders is used) were also incorporated into the model.

Finally, the Fundamental Forward Rate model has two components. The predicted values of the exchange rate lie between the  $F_+^{fund}(t, T)$  and  $F_-^{fund}(t, T)$  (see the two equations below). The  $a$  and  $q$  parameters are established by calibrating the model on historical data.

$$F_+^{fund}(t, T) = F^{teor}(t, T) + a \times \text{sgn}(F(t, T) - F^{teor}(t, T)) \times |F(t, T) - F^{teor}(t, T)|^q \times (1 + \eta)$$

$$F_-^{fund}(t, T) = F^{teor}(t, T) + a \times \text{sgn}(F(t, T) - F^{teor}(t, T)) \times |F(t, T) - F^{teor}(t, T)|^q \times (1 - \eta)$$

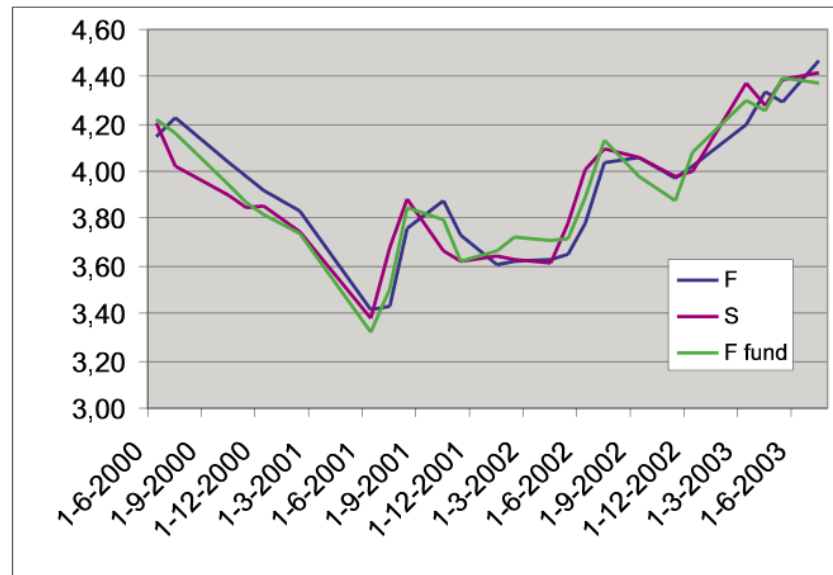
where  $\eta$  represents the number of uninformed traders. It is derived from either publicly available Trader Commitment Reports or an analysis of the bid-ask spread.

## 5. Using the model to predict future exchange rates

The model can be used to predict the values of fundamental forward rates and (indirectly) the future spot rates as well. Yet, it must be emphasized that the calculations are based on information available at time  $t$ . It is natural that new information arriving in the period  $(T-t)$  may gradually change the prediction.

The model was calibrated on three-year data sequences, starting July 1999. The parameters determined after each calibration complement the model. It is a typical one step prediction with a one month horizon<sup>5</sup>. As it can be seen below the values generated by the model are good predictions of future spot rates.

**Figure 2:** Prediction of the future spot PLN/EUR rate generated by FFR model



The quality of the prediction was verified through a set of statistical tests, such as MAE and Wilcoxon test. Two benchmarks were used for comparison : futures rates and the prediction generated by neural networks. The  $\pm 2,25\%$  band allowed by ERM II was another benchmark – 71% of the values generated by the model fall into the band. In general, the values generated by the model were significantly better than all the other benchmark values.

## Conclusions

To sum up, the procedure of accessing the euro zone involves setting a central PLN/EUR rate. The rate must be carefully chosen so the market rate would fit in  $\pm 2,25\%$  band around it while the central rate is being tested in the ERM II. The question that has not been answered yet is how to determine the central rate.

The model that has been presented in the paper proves efficient in predicting exchange rates. The only drawback is that some of the data necessary to feed the model are not easily available.

This paper, hence, should be considered only a small step in a promising line of research. It provides a valuable insight into how expectations with regard to future spot rates are formed in the futures market.

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#### (Footnotes)

<sup>1</sup> Cf: Floyd Norris, "A new villain emerges in Europe: the euro" in: International Herald Tribune, June 8, 2005

<sup>2</sup> Scott McNealy, "Is the euro forever?" in: Financial Times, June 8, 2005

<sup>3</sup> Scott McNealy, "Is the euro forever?" op.cit.

<sup>4</sup> Cf: [www.cftc.gov/cftccotreports.htm](http://www.cftc.gov/cftccotreports.htm)

<sup>5</sup> Example: Prediction for 25 January 2002 spot rate is given by (6). The parameters have been calibrated on historical data.  $F^{fund}(t, T) = 3,5456 + 0,12 \times (3,61 - 3,5456)^{(1/200)} = 3,66$  The value of theoretical forward rate (on 31 December 2001) is 3.5456 since 1M Wibar and Euro Libor were 0.1208 and 0.0333 and spot rate on this day was 3.52. The actual spot rate (on 25 January 2002) was 3.64 (please compare it to the prediction of 3.66).